Skilful Long Range Prediction of European and North American Winters

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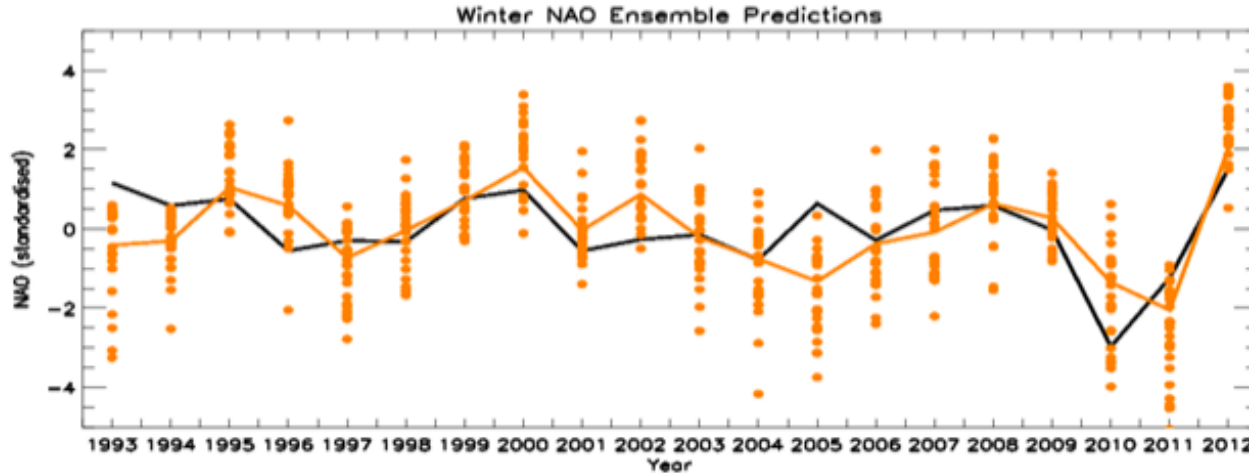
Met Office GloSea5

Global Seasonal Forecast System 5

Model: **HadGEM3H N216L85O(0.25)**

Initialisation: **NWP state + NEMOVAR + Sea Ice**

Winter Hindcasts: **24 members starting around 1 November**

NAO/AO predictable with GloSea5

Winter NAO Ensemble Predictions

Scaife et al, GRL, 2014

NAO skill: correlation=0.62

Significant at the 98% level

Similar results hold for AO and SAM

PNA shows higher predictability: correlation = 0.92

Forecast skill in blocking

(a)

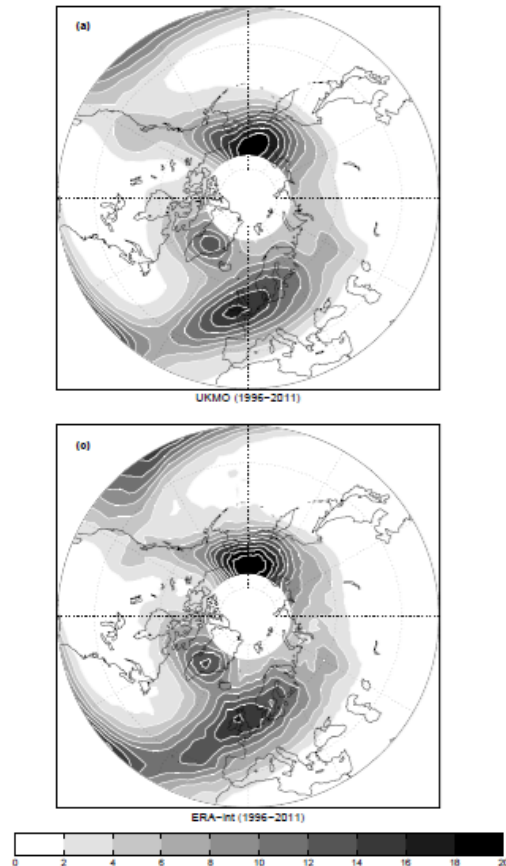UKMO (1996–2011)

(b)

ERA-int (1996–2011)

Figure 3: Two-dimensional winter (DJFM) climatologies of instantaneous blocking frequency (% of blocked days). See text for details on the blocking detection method. In (a) and (b) for the UKMO and the CMCC models, and in (c) and (d) for the corresponding periods of the ERA-Interim reanalysis. For the models, blocking detection is performed separately for each ensemble member. Here the average climatology is shown.

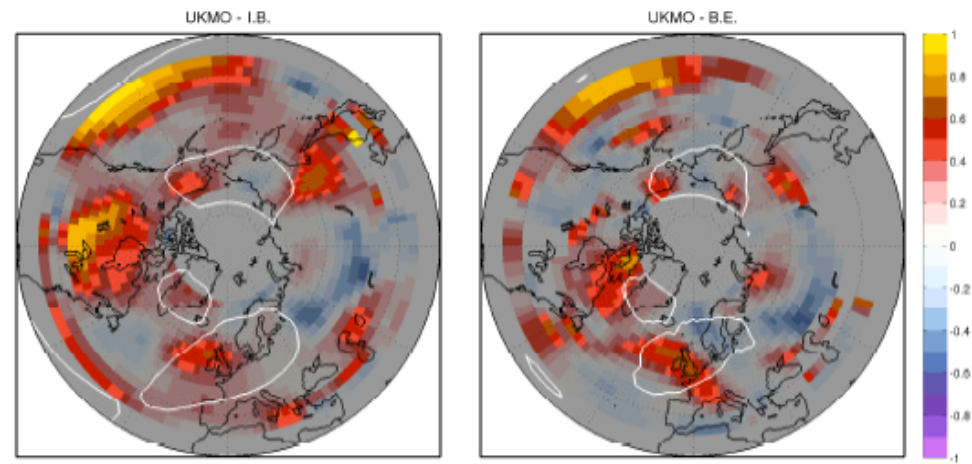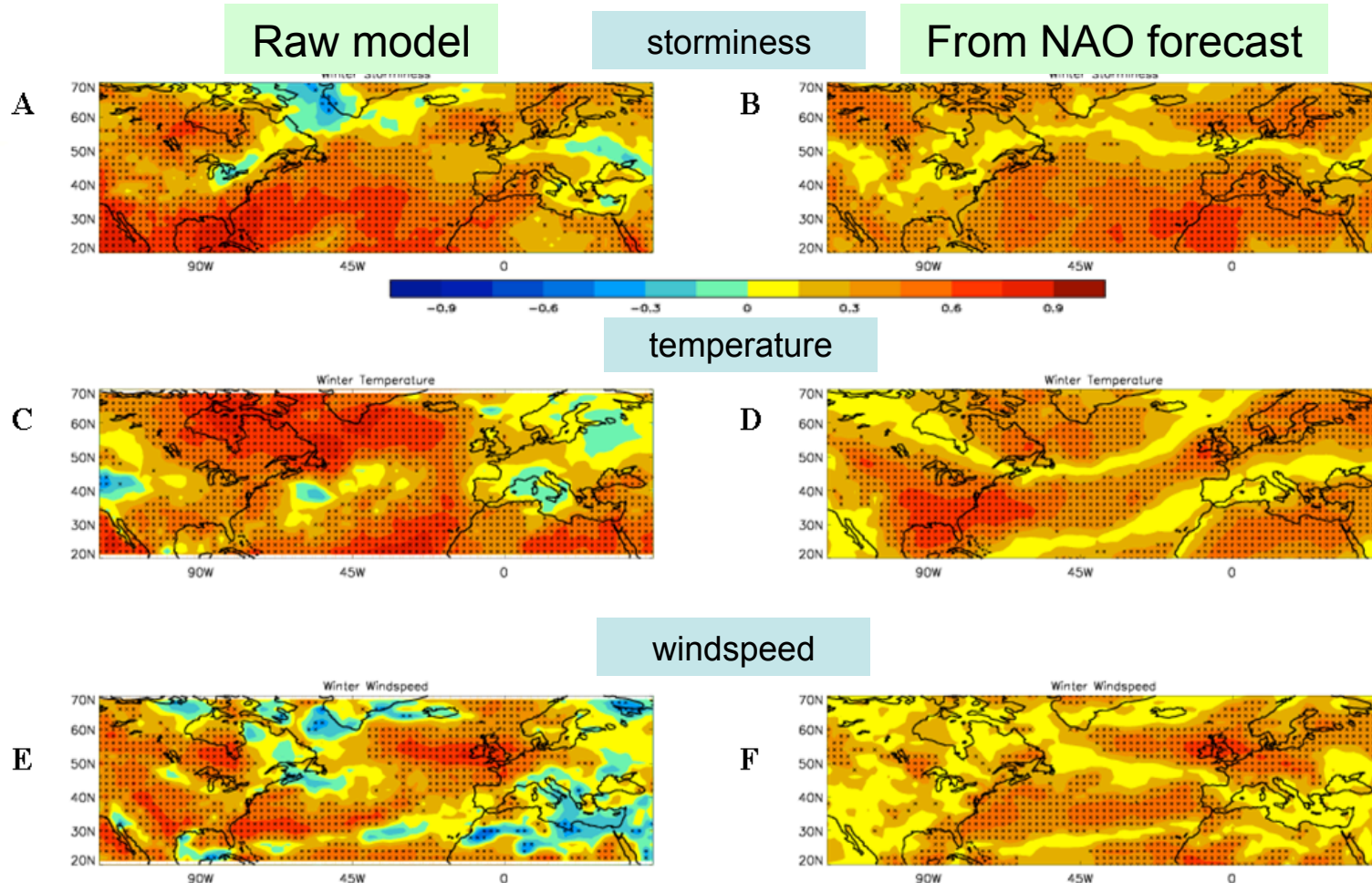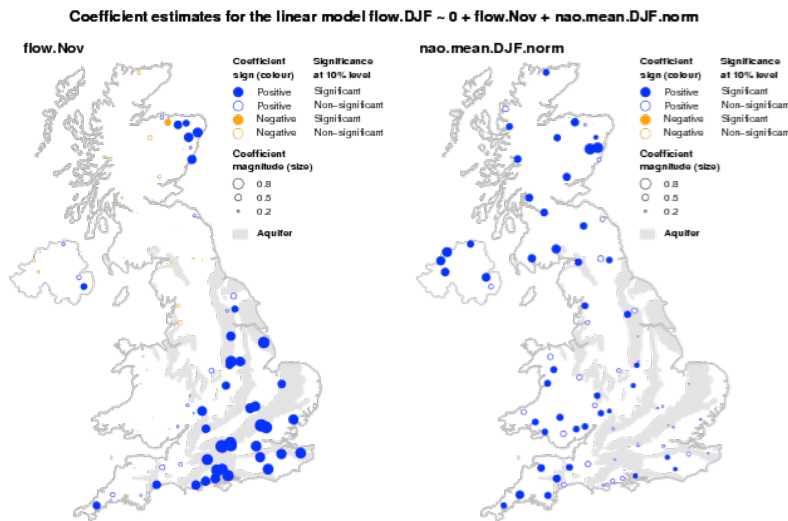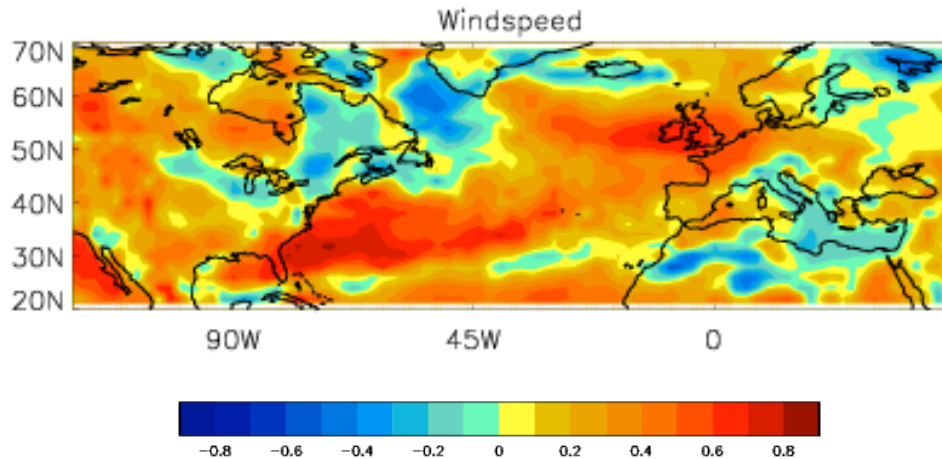UKMO - I.B.   UKMO - B.E.

Figure 13: Correlation coefficient maps between the forecasted and the observed winter-mean (DJFM) cumulative frequencies of (left) instantaneous blocking and (right) blocking evens. These are for the UKMO model at the top and for the CMCC model at the bottom. Blocking occurrences have been integrated within 10° lat.×20°lon. window centered at each grid point. A semi-opaque gray mask is applied to correlations that do not pass the significance testing (see text). The white contours correspond to the climatological blocking frequency levels of 8 for I.B. (Fig. 3) and 1.5 for B.E. (Fig. 4).

Athanasiadis et al, J.Clim., 2014

Surface weather skill

Raw model   storminess   From NAO forecast

temperature

windspeed

- Skill for predicting impacts: storms, temperatures, winds…
- Higher skill over Europe if inferred from forecast NAO only!

Scaife et al, 2014

Daily extremes and impacts

Windspeed

Coefficient estimates for the linear model flow.DJF ~ 0 + flow.Nov + nao.mean.DJF.norm

Prediction of the NAO

⇒ Prediction of winter extremes

⇒ Prediction of Impacts

Cold days (energy, transport..)

Storms (insurance…)

Windspeed (renewables…)

Hydrology (river flows…)

Svensson et al, 2014

Outstanding questions...

Signal and noise
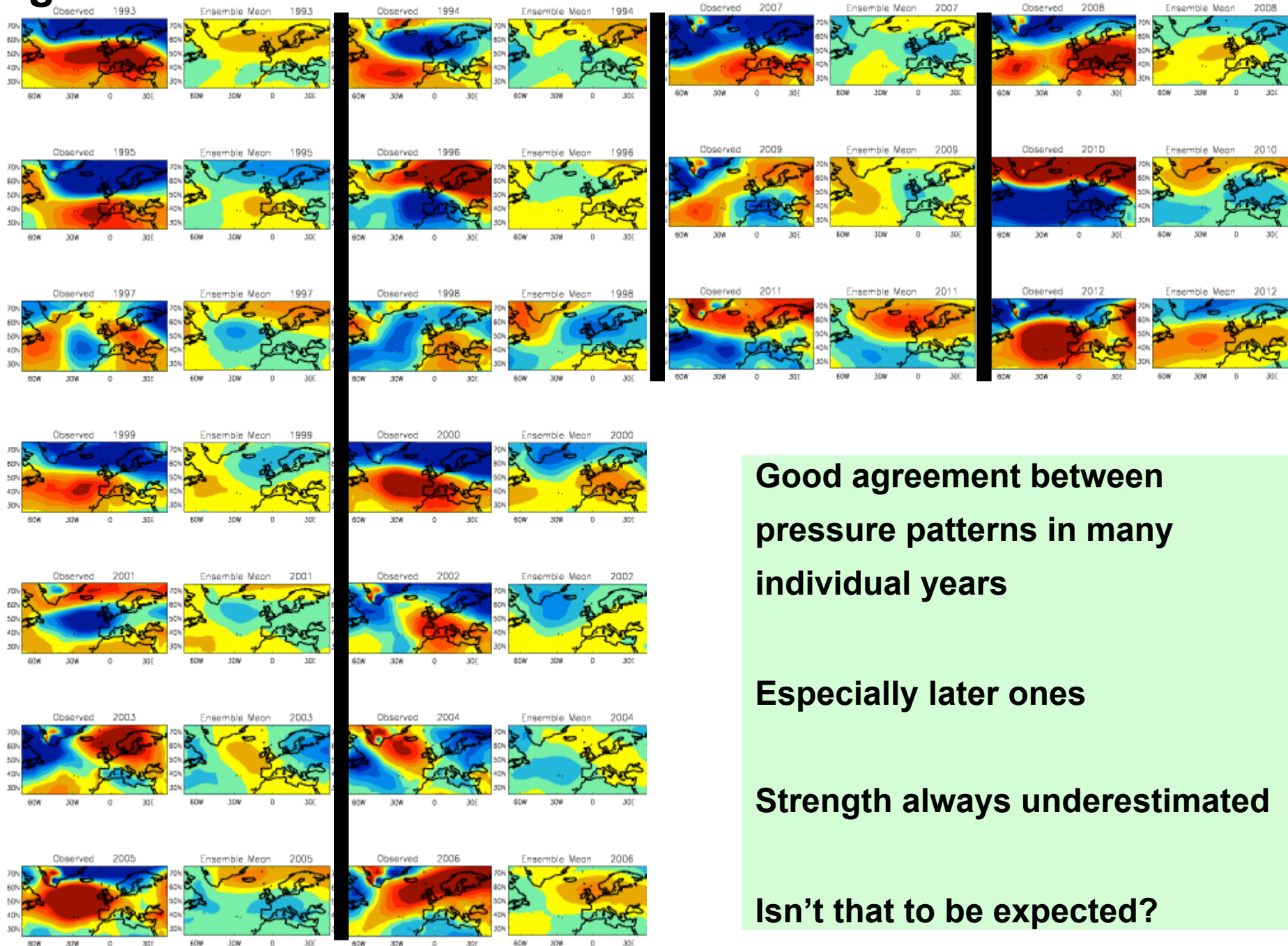
Good agreement between pressure patterns in many individual years

Especially later ones

Strength always underestimated

Isn't that to be expected?

Signal and noise

NAO Skill vs Ensemble Size
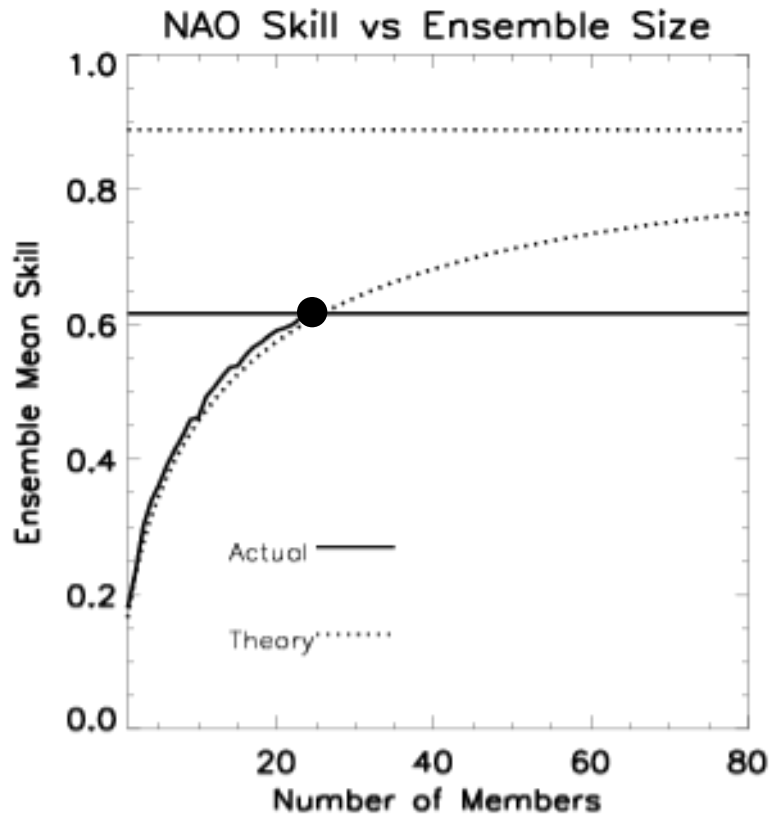
Resample for different ensemble sizes

Approaching theoretical asymptote

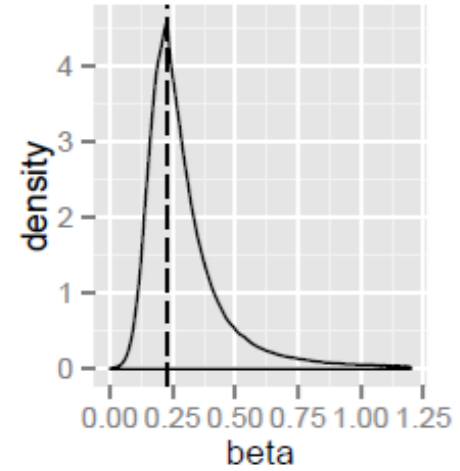> 0.8 is possible with this system!

BUT signal to noise is small ~0.2 ???

Kumar 2009

Signal to noise

Scaife et al, GRL, 2014
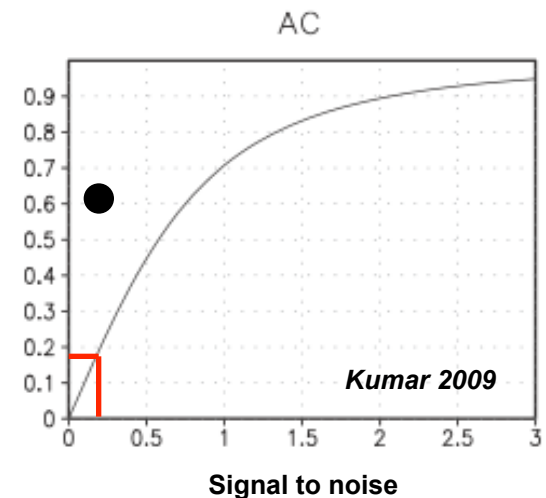
How confident are we of a signal to noise problem?

A toy model of the forecasts and observations as signal plus noise:

$$O = s + N \qquad\qquad M = \beta s + N$$

Probability that s/N is too low in model = 0.97

David Stephenson and Stefan Siegert, Exeter University, Met Office – Exeter University collaboration under EU SPECS

Anomalies in signal to noise ratio
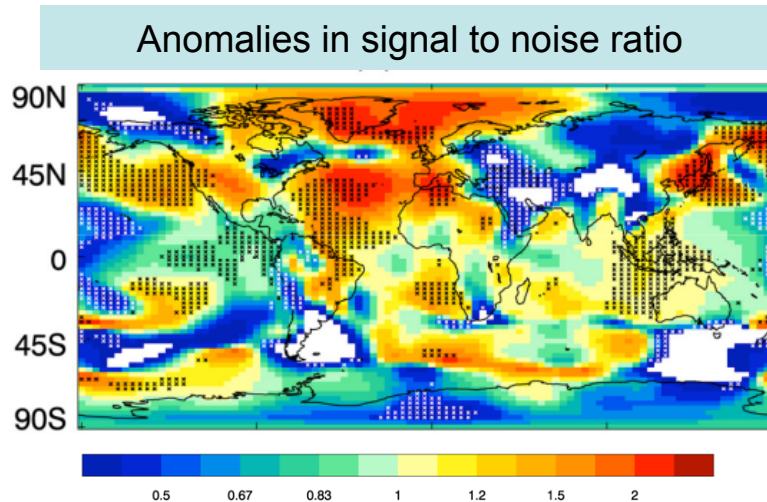
Signal to noise is too small in Atlantic

and perhaps also Pacific

(Eade *et al*, GRL, 2014)

Sources of predictability…
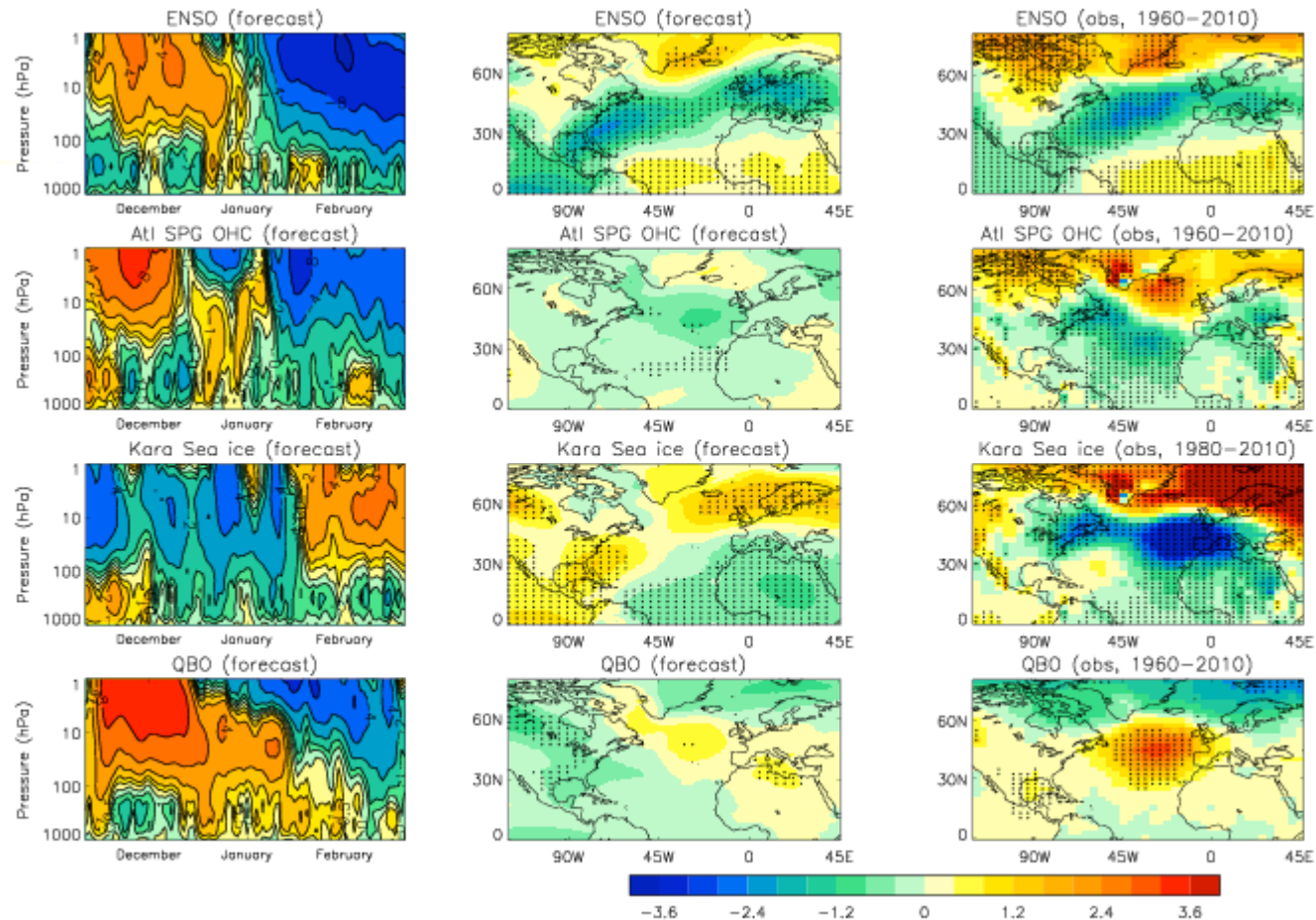
Strongest minus weakest cases for November predictors:

ENSO Niño3.4, Atlantic Tripole, Kara sea-ice, QBO

Responses are weaker in model than obs
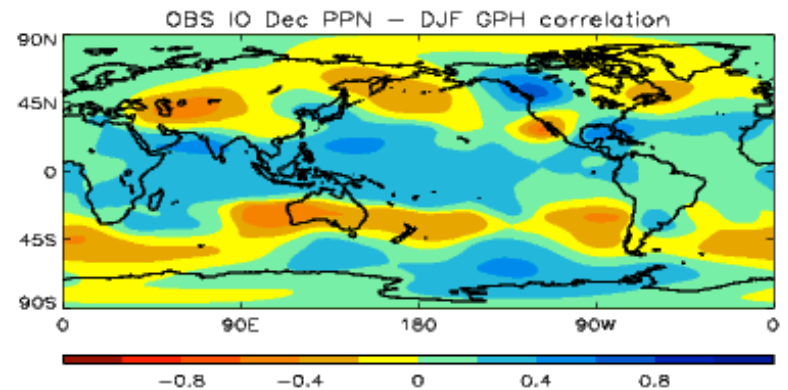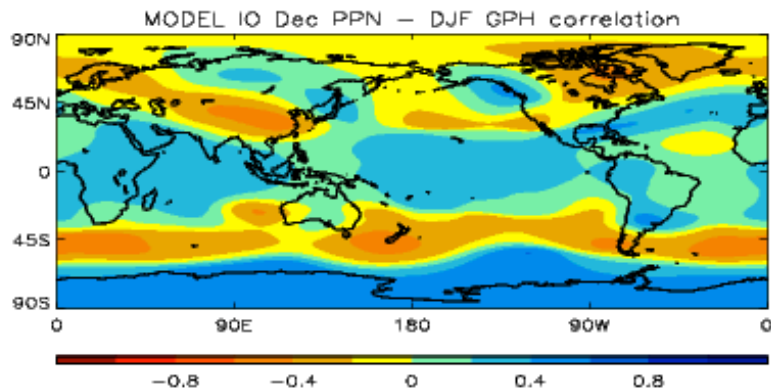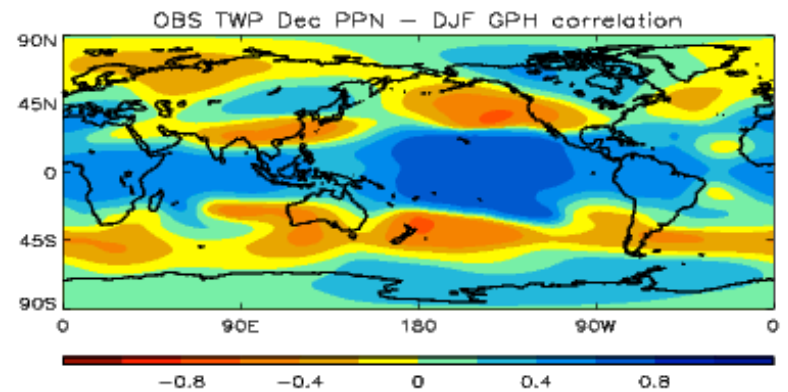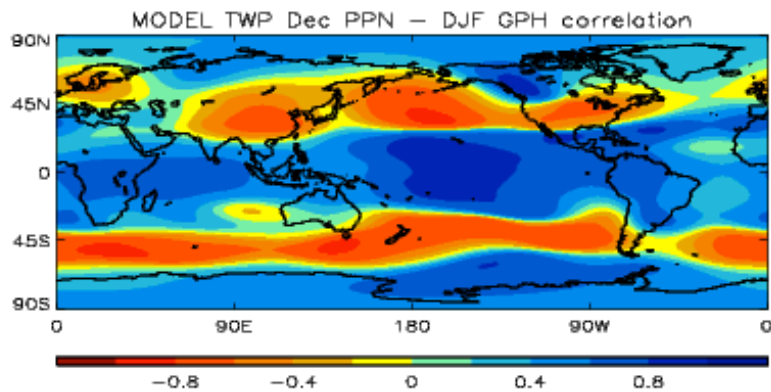
Scaife et al, GRL, 2014

Sources of predictability...
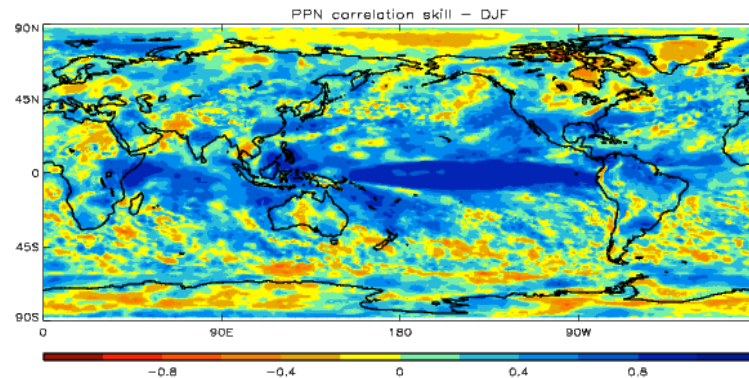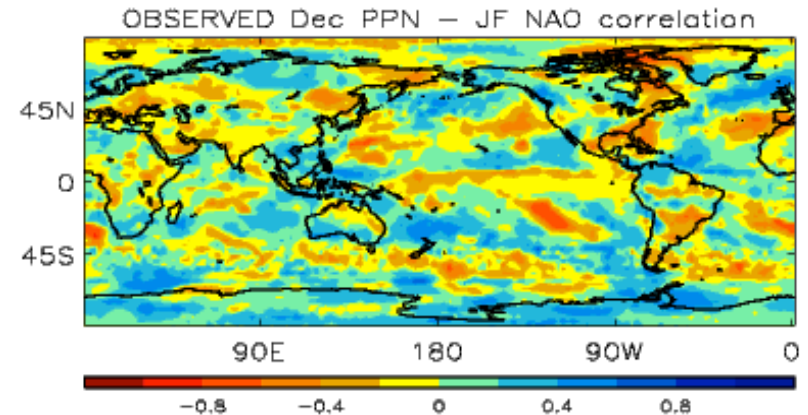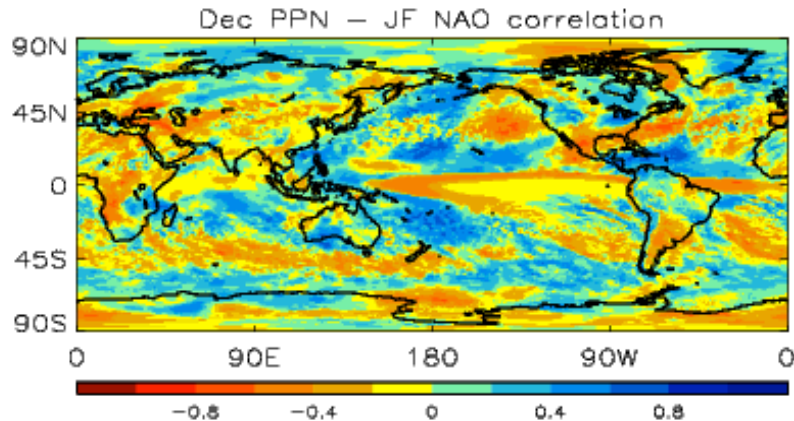
Tropical rainfall is correlated with following NAO
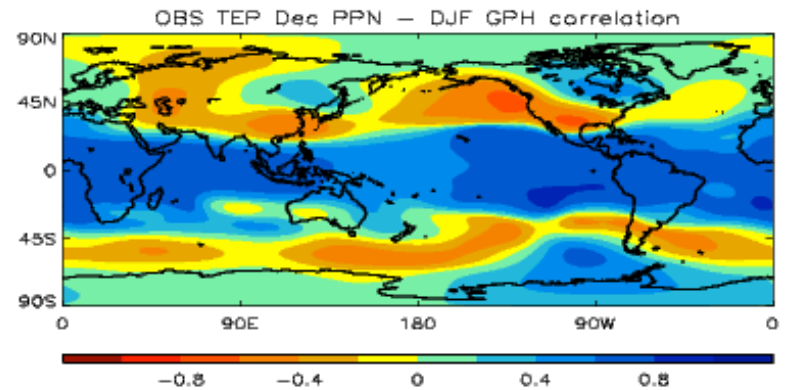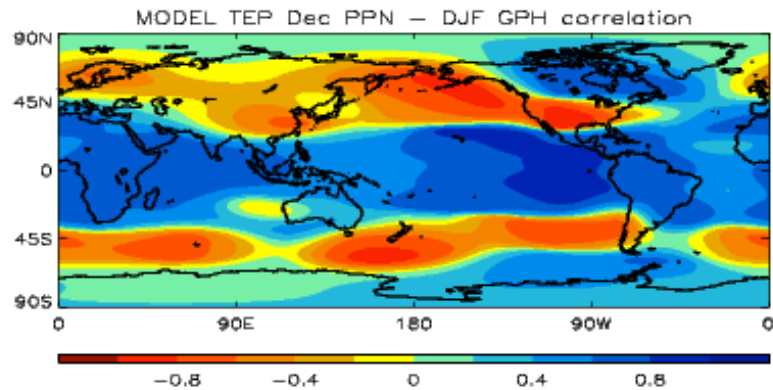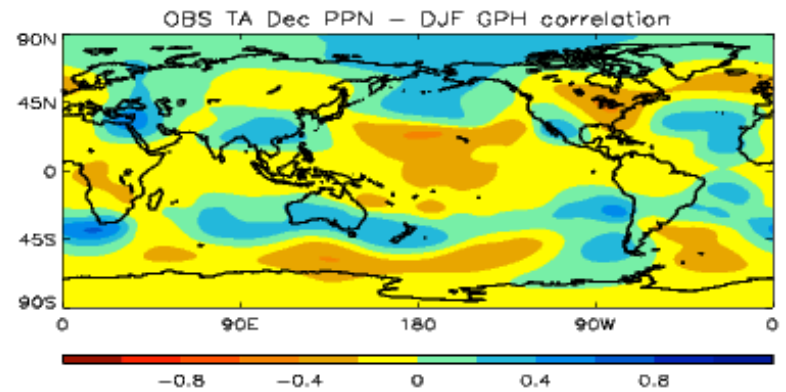
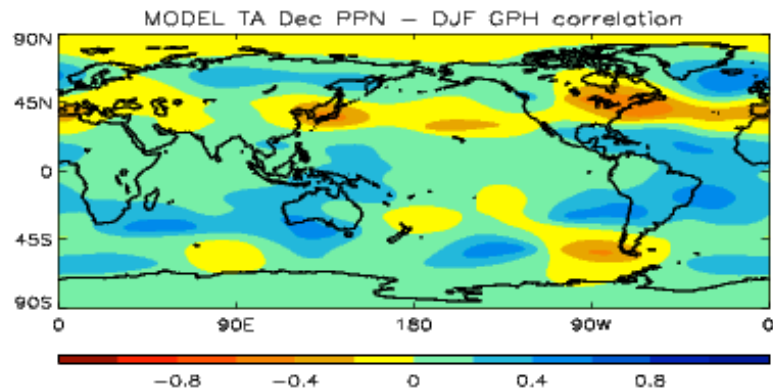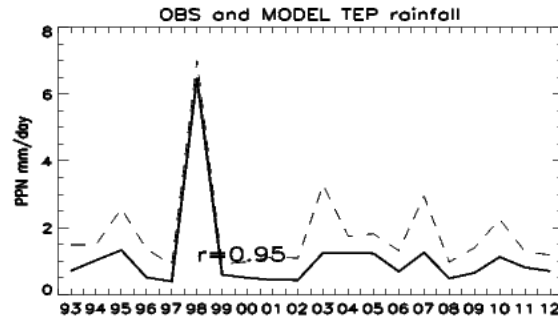Tropical rainfall predictions are very skilful

Teleconnections

Model teleconnections (left) and observations (right)

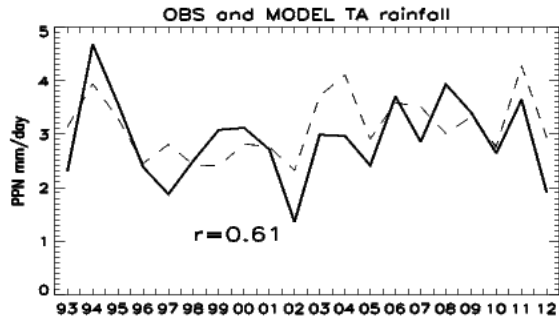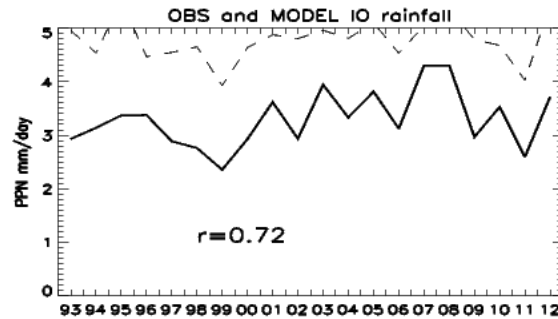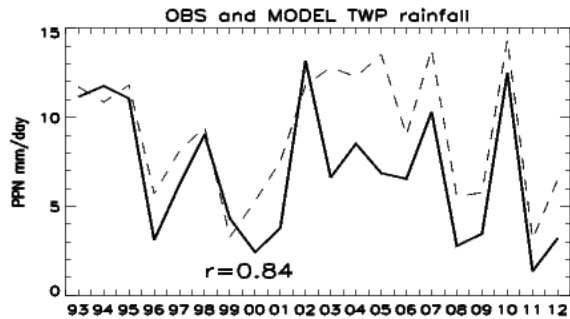Tropical W Pacific and Indian Ocean – look reasonable?

Teleconnections

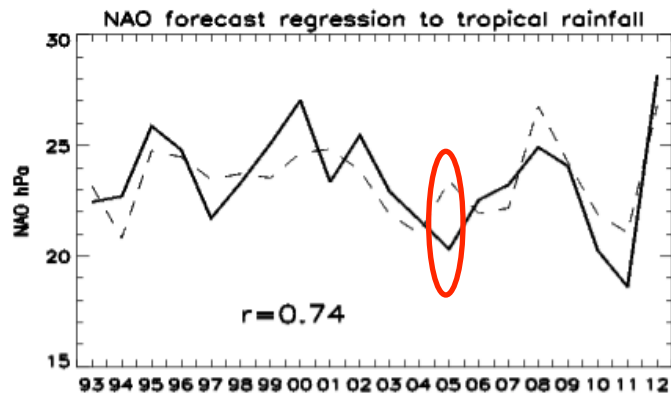Model teleconnections (left) and observations (right)

Tropical Atlantic – not so good?

Sources of predictability...

Tropical ppn well predicted

Correlation and amplitude

Tropical precip can explain NAO forecast

50% of variance...

Summary of where we are:

Skillful winter forecasts for Europe & N America

High predictability of the NAO/AO

Several sources of skill: many things ring the NAO bell

Anomalously low signal to noise ratio

Large ensembles needed > 100 members

Risk of daily extremes governed by large scale flow

Many downstream applications possible

Scaife A.A., et al (2014). Skilful Long Range Prediction of European and North American Winters. Geophys. Res. Lett., 41, 2514-2519.

MacLachlan C., A. et al. (2014). Description of GloSea5: the Met Office high resolution seasonal forecast system. Q. J. R. Met. Soc., submitted.

Eade R., D. Smith, A.A.Scaife and E. Wallace (2014). Do seasonal to decadal climate predictions underestimate the predictability of the real world? Geophys. Res. Lett., submitted.